

CLAIMS

What is claimed is:

1. An exchange device comprising:

a thermoplastic housing having one or more hollow conduits; said hollow conduits fluidly sealed by a thermoplastic resin and bonded to an end portion of said housing; the end portion of the housing having one or more grooves; said grooves and resin forming a unitary end structure wherein the resin and housing fuse at a portion of said groove to form said unitary end seal.

2. The exchange device of claim 1 having a sintered thermoplastic coating on the inside of said housing.

3. The exchange device of claim 1 wherein said housing includes fluid fittings.

4. The exchange device of claim 1 wherein two or more grooves are interconnected by vent channels.

5. The exchange device of claim 1 wherein said hollow conduit are perfluorinated porous hollow fibers, perfluorinated skinned hollow fibers, perfluorinated conduits, perfluorinated co-extruded hollow conduits, or combinations of these.

6. The exchange device of claim 1 wherein the ends of the hollow conduits are opened.

7. An exchange device comprising:

one or more thermoplastic hollow conduits fused at a first end portion of the conduits to a thermoplastic resin; said thermoplastic resin fused to one or more structures on an interior surface of a first sleeve or to a first end of thermoplastic housing; and

a second end portion of the thermoplastic hollow conduits fused with a thermoplastic resin; said thermoplastic resin fused to one or more structures on an

interior surface of a second sleeve or to a second end of the thermoplastic housing.

8. The exchange device of claim 7 where the structures are protrusions, grooves, or a combination of these.
9. The exchange device of claim 7 where the structures are grooves in the surface of the housing or sleeves.
10. The exchange device of claim 7 having a sintered thermoplastic coating on the inside of the sleeve or housing.
11. The exchange device of claim 7 wherein said housing or sleeve includes fluid fittings.
12. The exchange device of claim 9 having two or more grooves in the housing or sleeves that are interconnected by vent channels.
13. The exchange device of claim 7 wherein the hollow conduit are porous hollow fibers, skinned hollow fibers, thermoplastic conduits, co-extruded hollow conduits, or combinations of these.
14. The exchange device of claim 7 wherein the ends of the hollow conduits are opened to fluid flow.
15. The exchange device of claim 7 wherein the thermoplastic conduits include a perfluorinated thermoplastic.
16. An exchange device comprising:
 - one or more co-extruded thermoplastic hollow conduits fused at a first end portion of the conduits to a thermoplastic resin; said thermoplastic resin fused to a surface of a first sleeve or to a surface of a first end of thermoplastic housing; and
 - a second end portion of the thermoplastic hollow conduits fused with a thermoplastic resin; said thermoplastic resin fused to a surface of a second sleeve or to a surface of a second end of the thermoplastic housing.

17. The exchange device of claim 16 wherein the ends of the hollow conduits are opened to fluid flow.
18. The exchange device of claim 16 wherein said housing or sleeve includes fluid fittings.
19. The exchange apparatus of claim 16 where the outer layer of the co-extruded conduit includes a thermally conductive material.
20. The exchange apparatus of claim 20 where the co-extruded conduits have an inner layer thermally bonded to an inner layers, the outer layer fusing with a thermoplastic resin in the exchange device.
21. A method of treating a fluid comprising:
 - flowing a fluid to be treated on a first side of one or more thermoplastic hollow conduits, the hollow conduits fused at a first end portion of the conduits to a thermoplastic resin; the thermoplastic resin fused to one or more structures on an interior surface of a first sleeve or to a first end of thermoplastic housing and where a second end portion of the thermoplastic hollow conduits is fused with a thermoplastic resin; the thermoplastic resin fused to one or more structures on an interior surface of a second sleeve or to a second end of the thermoplastic housing; and
 - flowing an exchange fluid on a second side of the thermoplastic hollow conduits to transfer mass, energy, or a combination of these is between the first and second fluids through a wall between the first and second side of the hollow conduits.
22. The method of claim 21 wherein thermal energy is transferred.
23. The method of claim 21 wherein said conduit wall is non-porous.
24. The method of claim 21 wherein the grooves are interconnected by vent slots.
25. An apparatus comprising:

an exchange device having one or more thermoplastic hollow conduits fused at a first end portion of the conduits to a thermoplastic resin; said thermoplastic resin fused to one or more structures on an interior surface of a first sleeve or to a first end of thermoplastic housing; and a second end portion of the thermoplastic hollow conduits fused with a thermoplastic resin; said thermoplastic resin fused to one or more structures on an interior surface of a second sleeve or to a second end of the thermoplastic housing.

a source of exchange fluid connected to a first fluid inlet of the exchange apparatus and a source of process fluid connected to a second fluid inlet of the exchange apparatus, the first and second fluid inlets separated by the hollow tubing, and a fluid controller fluidly connected to an exchanger outlet in fluid communication with the second fluid inlet, the fluid controller providing conditioned fluid to one or more substrates to be treated by the apparatus.

26. The apparatus of claim 25 wherein the exchanger outlet in fluid communication with the second fluid inlet provides conditioned fluid to a tank containing one or more substrates.
27. The apparatus of claim 25 wherein the fluid controller is a pump, a dispense pump, or a liquid flow controller.
28. The apparatus of claim 25 wherein the exchange fluid is a source of temperature controlled fluid.
29. The apparatus of claim 25 wherein the substrate to be treated includes silicon.
30. An exchange device comprising:

potted hollow conduits in a housing capable of transferring heat from a first fluid to a second fluid through the walls of the hollow conduits, the exchange device integral at a temperature of at least 100 °C and a pressure of at least 50 psig, the hollow conduits having a packing density by volume of hollow conduits in the housing of from between 20 and 70 percent,

31. The exchange device of claim 30 with potted hollow conduits having 9 ft² (0.85 m²) of exchange surface area, the exchange device capable of exchanging at least about 13,000 watts of energy between a first fluid flowing on a first side of the hollow conduit with a second fluid flowing on a second side of the hollow conduits.
32. The device of claim 31 where the first fluid flows at a rate of 9.5 liter per minute or less on a first side of the hollow conduits and the second fluid flows at a rate of 5.8 liter per minute or less on the second side of the hollow conduits.
33. The exchange device of claim 30 where the device is integral at a temperature of 160 °C and a pressure of 70 psig.
34. The exchange device of claim 30 where the device is integral at a temperature of 200 °C and 50 psig.
35. The exchange device of claim 30 where the device includes co-extruded perfluorinated hollow conduits.
36. The exchange device of claim 30 where the hollow conduits are made from perfluorinated thermoplastics.